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PRIMALITY OF A CERTAIN CLASS OF INTEGERS

by

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Computing Laboratory

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ABSTRACT

This report is concerned with determining the primeness of the members of a class of numbers of the form, $B_p = \frac{2^p + 1}{3}$, where p is an odd prime. This class is similar to the Mersenne and Fermat numbers. A theorem is proven which characterizes the factors of B_p. This study was conducted using BRLESC, the high-speed digital computer at BRL and a description is given of the program used. Finally, the B_p's that were found to be prime as well as the B_p's that were found to be composite are tabulated.

The Mersenne numbers, which have the general form $M_p = 2^p - 1$, and the family of numbers, the Fermat numbers, which have the form $F_p = 2^p + 1$, have been studied for centuries. Just recently a renewed interest in them has been brought about by the use of the high-speed computers (see, for example, [3]*).

Since the Fermat numbers cannot be prime unless p is a power of two (i.e., unless $p = 2^m$ for some integer m), the Fermat numbers have been defined as $F_m = 2^{2^m} + 1$ and this is the form in which they have been investigated. To see that F_p is composite when p is not a power of two, first note that a power of two cannot have any odd factors. Hence, if p is not a power of two, we can write $p = rs$, where $s > 1$ is odd. Using the fact that when m is odd

$$x^m + y^m = (x + y)(x^{m-1} - x^{m-2}y + x^{m-3}y^2 - \dots - xy^{m-2} + y^{m-1}) \quad ,$$

we substitute $x = x^n$, $y = y^n$ obtaining

$$x^{mn} + y^{mn} = (x^n + y^n)(x^{n(m-1)} - x^{n(m-2)}y^n + x^{n(m-3)}y^{2n}$$
$$- \dots - x^n y^{n(m-2)} + y^{n(m-1)}) \quad .$$

Therefore, we have

$$2^p + 1 = 2^{rs} + 1 = (2^r + 1)(2^{r(s-1)} - 2^{r(s-2)} + 2^{r(s-3)} - \dots - 2^r + 1)$$

which shows that F_p has a factor of $2^r + 1$.

This paper is concerned with the case of p equal to an odd prime, so that

$$2^p + 1 = (2 + 1)(2^{p-1} - 2^{p-2} + 2^{p-3} - \dots - 2 + 1)$$

$$2^p + 1 = 3\left[(2^{p-1} - 2^{p-2}) + (2^{p-3} - 2^{p-4}) + \dots + (2^2 - 2) + 1\right]$$

$$2^p + 1 = 3\left[2^{p-2}(2 - 1) + 2^{p-4}(2 - 1) + \dots + 2(2 - 1) + 1\right]$$

$$2^p + 1 = 3(2^{p-2} + 2^{p-4} + \dots + 2 + 1) \quad .$$

* *Numbers in brackets refer to references found on page 20.*

Clearly, F_p always has a factor of 3 when p is an odd prime. This gives rise to the definition of a new family of numbers, B_p, where p is an odd prime and

$$B_p = \frac{2^p + 1}{3} .$$

The following two lemmas are used in the proof of theorem I and this result is utilized in determining the primeness of B_p.

Lemma 1: $M_p \equiv 1 \pmod{p}$, for any odd prime p.

Proof: By Fermat's theorem, $2^{p-1} \equiv 1 \pmod{p}$ or $2^p \equiv 2 \pmod{p}$, [2, p. 277]. Subtracting one from both sides, we have $2^p - 1 \equiv 1 \pmod{p}$.

Lemma 2: $B_p \equiv 1 \pmod{p}$, for any prime $p > 3$.

Proof: Adding $2^p \equiv 2 \pmod{p}$ and $1 \equiv 1 \pmod{p}$, we obtain $2^p + 1 \equiv 3 \pmod{p}$. Since $2^p + 1$ has a factor of 3 and the greatest common divisor of p and 3 is 1 whenever $p > 3$ and p is prime, it follows that

$$B_p = \frac{2^p + 1}{3} \equiv 1 \pmod{p}, \text{ [2, p. 223]} .$$

<u>Theorem I</u>. If B_p is composite with prime factor q and p is a prime greater than 3, then q must be of the form $q = 2kp + 1$ for some $k = 1, 2, 3, \ldots$.

Proof: By D. H. Lehmer's Law of Apparition, it follows that p is some divisor of $q - \sigma\epsilon$, where $B_p \equiv \epsilon \pmod{p}$ and $M_p \equiv \sigma \pmod{p}$, see [1]. By the previous lemmas, $\epsilon = \sigma = 1$. Therefore, $q - 1 = k'p$ for some k'. Since B_p is odd, q must also be odd. Consequently, $k'p$ is even; and since p is an odd prime, k' must be even. We can therefore set $k' = 2k$ for some integer k and hence q is of the form $q = 2kp + 1$.

<u>Theorem II</u>. If k in theorem I is odd, then q is of the form $q = 8n + 3$; and if k is even, then q is of the form $q = 8n + 1$, for some integer n.

Proof: Since $q = 2kp + 1$,

$$\frac{q-1}{2} = k\,p .$$

Euler's Criterion states that if $2^{\frac{q-1}{2}} \equiv 1 \pmod{q}$, then 2 is a quadratic residue of a prime q; and if $2^{\frac{q-1}{2}} \equiv -1 \pmod{q}$, then 2 is a non-residue of a prime q, [4, p. 203].

Case A. k is even. In this case,

$$2^{\frac{q-1}{2}} = 2^{kp} = (2^p)^k \equiv (-1)^k \equiv 1 \pmod{q} .$$

Hence by Euler's Criterion, 2 is a quadratic residue of q. By induction, $q = 8n + 1$ or $q = 8n + 7$, see [4, p. 278]. Since, by theorem I, we know $q = 2kp + 1$, $q \neq 8n + 7$ for any n. Therefore, $q = 8n + 1$ for some integer n.

Case B. k is odd. Now, $(-1)^k = -1$ and hence

$$2^{\frac{q-1}{2}} = 2^{kp} = (2^p)^k \equiv (-1)^k \equiv -1 \pmod{q} .$$

2 is therefore a non-residue of a prime q. By induction, $q = 8n + 3$ or $q = 8n + 5$ for some integer n, [4, p. 278]. Again, since $q = 2kp + 1$, $q \neq 8n + 5$ for any n. Hence $q = 8n + 3$ for some n.

Using BRLESC, the high-speed digital computer of the Ballistic Research Laboratories, a program was written to determine the primeness of B_p for odd prime numbers p. This was accomplished by dividing by all possible divisors of the form $q = 2kp + 1$. B_p was first examined for all odd primes less than 61, since this is the maximum word length of BRLESC. The results were that B_p is prime for p = 3, 5, 7, 11, 13, 17, 19, 23, 31, 43. For p = 29, 37, 41, 47, 53, 59, B_p is composite with factors 59, 1777, 83, 283, 107, 2833 respectively.

B_{61} was tested by determining whether or not the congruence $2^{61} \equiv -1 \pmod{122\,k + 1}$ held for some k. For $k \leqq 51{,}365$ this congruence was not satisfied; and hence, if B_{61} has a factor, it must be between 6,266,531 and $\sqrt{(2^{61} + 1)/3}$.

Similarly, B_{67} was tested and found to have no factors less than or equal to 4,365,319 (k = 32,577). Time did not permit these to be extended further.

When the program became too time consuming, a new program was written to determine the set of B_p's that were not prime. The following method was used. A prime number q greater than three was generated. Then the smallest integer $n > 0$ was found such that $2^n \equiv 1 \pmod{q}$ or $2^n \equiv -1 \pmod{q}$. If $2^n \equiv 1 \pmod{q}$, then $2^{n+1} \equiv 2 \pmod{q}$ and the system of residues is cyclic with order n. Therefore, $2^n \not\equiv -1 \pmod{q}$ for all n, so that q is a factor of B_p for no p. Also, if $2^n \equiv -1 \pmod{q}$ and n is not a prime, then we can conclude that q is a factor of B_p for no p. To see this, assume there does exist some prime integer m such that $m > n$ and $2^m \equiv -1 \pmod{q}$. Since $2^n \equiv -1 \pmod{q}$ implies $2^{2n} \equiv 1 \pmod{q}$, we know by the above argument the system of residues is cyclic with order 2n. Therefore, $n < m < 2n$. By the algebra of congruences, $2^m - 2^n \equiv [(-1) - (-1)] \pmod{q}$ or $2^m - 2^n \equiv 0 \pmod{q}$. Since $2^m - 2^n = 2^n(2^{m-n} - 1)$ and q divides $(2^m - 2^n)$ but not 2^n, it follows that q divides $2^{m-n} - 1$. But this implies $2^{m-n} \equiv 1 \pmod{q}$. Since $m - n < n$, this result contradicts the assertion that n is the least integer such that $2^n \equiv \pm 1 \pmod{q}$. Hence, q is a factor of B_p for no p. Finally, when $2^n \equiv -1 \pmod{q}$ and n is prime, we have that q is a factor of $2^n + 1$. Since $q > 3$, q is, therefore, a factor of B_n.

This program has the advantage that, given a prime q, one can readily find the p such that q divides B_p, if such a p exists. Hence, a systematic check with each prime q will discover all p such that B_p has a factor in the group of integers with prime factors less than or equal to q.

It took BRLESC almost 22 hours to compute all primes q, $q \leq 299{,}087$, find an n such that $2^n \equiv 1$ or $-1 \pmod{q}$ and then determine whether or not n was prime. Of the 25,959 prime numbers less than or equal to 299,087, we found 1330 B_p's that were composite. Of these, 1262 B_p's had only one factor less than 299,087; 59 B_p's had two factors less than 299,087; 7 had three factors less than 299,087; and 2 had four factors less than 299,087. In examining 25,959 prime numbers, 5.4% turned out to be factors of the B_p's.

Finally, on the basis of these results, it would seem that prime B_p are more frequent than prime M_p. From the first 16 odd primes, there are 7 prime M_p compared with 10 prime B_p.

Below is a complete table giving all p such that B_p has a factor q, $q \leq 299,087$. Printed beside the p is the corresponding k such that $q = 2kp + 1$ is a factor of B_p.

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NUMERICAL RESULTS

p	k	p	k	p	k	p	k
29	1	419	7	977	4	1613	12
37	24	421	5	1013	1	1621	9
41	1	443	55	1021	5,9	1669	14
47	3	449	217	1039	75	1699	35
53	1	461	108,120	1049	1	1733	1,40
59	24,315	479	4,40	1103	103	1789	12
73	12	499	164	1151	4,115	1823	3,12
83	3,7,16,936	509	1	1153	12	1889	1
89	1	541	80	1171	11,36	1901	1
97	5,8,164	557	4,112	1181	21,25	1933	72
107	3	569	9	1229	1	1973	1
113	1,216	571	8	1237	8	1987	3
131	4	577	65	1249	17	2027	3
137	4,57	593	1	1283	3	2069	1,7
149	4	607	95	1289	1,9,12	2081	4
157	48	617	4	1291	11	2129	1,4
173	1,12	641	1,25,109	1307	4	2141	1
181	5	653	1	1327	3	2203	3
211	11	659	51,216	1361	4	2221	9
227	655	661	156	1399	12	2239	24
233	1,60	719	24	1409	1	2251	8
241	5	727	8	1439	7	2273	1
251	475	743	15	1451	3	2281	5,21
263	3,175	751	183	1481	1,49	2339	4
271	3	761	1	1499	15	2341	21,48
281	1	769	24	1511	3	2347	3
283	3,111	809	1,9,12	1523	7	2377	29
293	1,45,57	821	4	1531	3	2381	48
311	103	877	17	1559	4	2383	12
331	8	881	13,33,40,85	1567	3	2393	1
337	32	883	12,167	1571	4	2399	7
367	3,27	887	3	1579	11	2447	3,4
373	81	947	4,7	1601	1	2477	9,13,24
397	17	953	1	1609	5	2549	1

p	k	p	k	p	k	p	k
2551	3	3583	3	4643	7	5867	7
2609	4	3593	1	4657	32	5927	15
2689	5	3631	3	4663	8	5939	4,12
2693	1,13	3643	12	4679	12,27	6011	3
2707	8	3671	3	4703	3	6053	1
2711	3,36	3677	13	4729	12	6079	12
2719	32	3691	3	4733	1	6101	1
2741	1,9	3761	1,4	4783	11	6113	1
2753	1	3769	5	4793	1	6163	3
2767	8	3821	1	4813	5	6173	1
2851	3	3881	9	4817	13	6199	11
2903	3	3917	4	4889	4	6269	4,10
2927	4	3947	7	4967	3	6329	1
2939	16	3967	35	4957	20	6337	17
2957	12	3989	37	5011	23	6367	8
2969	1	4001	4,28	5021	25	6449	1
2999	4	4013	28	5081	1,24	6521	1,16
3037	8	4049	9,12	5113	5,20	6569	4
3061	45	4051	8,11	5147	4	6571	8
3121	9,29	4073	1	5189	25	6581	1
3203	7	4139	7	5309	4	6653	12
3209	4	4201	8	5333	1	6689	21
3221	21	4229	9	5381	4	6691	8,15
3253	20,36	4259	12	5399	15	6709	12
3307	3,23	4327	20	5437	5	6739	4,9
3323	7	4349	1,9	5441	1	6761	1
3329	1	4357	20	5501	1	6793	5
3361	8	4373	1	5569	12	6803	3
3389	1	4391	3,15	5647	8	6823	11
3391	3	4409	1	5669	9	6863	3
3413	1	4421	9	5741	1	6871	8
3449	1	4441	9	5783	7	6883	20
3457	8	4481	1	5813	21	6911	3
3491	3	4513	17	5827	23	6947	7
3533	12	4517	4	5843	3	6961	9
3547	3	4547	3	5849	1	6991	3

p	k	p	k	p	k	p	k
7121	1	8447	12	10589	1	12251	4
7193	1	8513	1	10607	4	12289	5
7219	15	8663	7	10613	1	12301	8
7229	12	8677	5	10709	1	12329	1
7253	13	8693	1	10733	1	12377	4
7333	12	8741	1	10771	3	12487	3
7349	1	8753	16	10781	1	12541	8
7433	1	8779	11	10861	8	12577	8
7541	1	8783	7	10889	9	12601	9
7561	9,8	8969	1	10903	3	12637	9
7573	8	9029	1	10937	12	12653	1
7607	15	9091	3	11159	4	12689	4
7649	1	9221	1	11257	5	12763	3
7703	16,3	9293	1	11273	13	12791	4
7757	4	9419	4	11287	3	12809	9
7841	1	9473	1	11317	5	12821	1
7853	16	9479	4	11321	1	12911	1
7901	1	9587	15	11369	1	12933	12
7963	3	9629	1	11393	1	12983	3
8059	15	9677	4	11437	5	13001	1
8069	1	9689	1	11549	1	13037	4
8087	3	9769	12	11593	5	13049	1
8093	16,1	9923	7	11621	9	13163	3
8101	9	9931	15	11657	4	13183	8
8123	7	10061	1	11743	3	13229	1
8167	3	10243	11	11801	1	13297	5
8179	11	10253	1	11813	1	13313	1
8237	13	10259	4	11821	5	13331	4
8243	3	10271	3	11909	1,4	13381	5
8263	11	10303	3	11953	8	13417	5
8273	1	10313	1	12007	3	13553	1
8291	3	10357	12	12041	1	13591	3,8
8297	13,4	10391	3	12101	1	13649	1
8363	12	10427	4,3	12197	4	13669	5
8431	3	10529	1	12227	3	13721	9

p	k	p	k	p	k	p	k
13841	4	15401	1	17351	3	19709	1
13873	5	15569	1	17387	3	19739	7
13901	1	15629	1	17449	5	19889	1
13913	1	15647	7	17467	3	19913	1
14009	1	15737	4	17471	3	19919	7
14051	3	15767	3	17491	3	19979	4
14081	1	15773	1	17657	4	20011	3
14153	1	15907	3	17669	1,4	20021	4
14207	3,4,7	15923	3	17681	1	20063	7
14249	1	15937	8	17707	3	20147	7
14281	5	16001	1	17783	3	20249	1
14321	1	16061	9	17827	3	20369	1
14327	4	16127	3	17971	3	20393	1
14423	3	16139	4	17981	1	20441	1
14431	3	16253	1	18041	1	20641	5
14461	5	16301	1	18149	1	20693	1
14489	1	16381	5	18191	3	20743	3
14561	1	16411	3	18233	1	20753	1
14621	1	16421	1	18251	4	20789	1
14657	9	16493	1	18341	1	20807	4
14669	1	16553	1	18461	1	20921	1
14723	3	16573	8	18523	8	21011	3
14741	1	16607	3	18773	1	21013	5
14747	4	16619	4	18911	3	21089	1
14771	4	16673	1	18959	4	21149	1
14869	5	16747	3	19139	4	21179	7
15061	5	16763	7	19183	3	21221	1
15101	1	16931	4	19259	4	21227	3
15107	7	17107	3	19301	1	21341	1
15131	3	17159	4	19373	1	21391	3
15161	1	17183	3	19433	1	21487	3
15173	1	17207	7	19553	1	21563	3
15233	1	17231	3	19597	5	21647	4
15269	1	17321	4	19603	3	21701	1
15391	3	17333	1	19661	1	21713	1

p	k	p	k	p	k	p	k
21727	3	23753	1	26189	1	29201	1
21737	4	23831	4	26371	3	29411	3
21893	1	23833	5	26407	3	29453	1
21929	4	23909	1	26501	1	29483	3
21997	5	23911	3	26573	1	29663	3
22003	3	23981	1	26597	4	29873	1
22013	1	24023	3	26633	1	30011	4
22067	3,4	24071	3	26641	5	30187	3
22111	3	24281	1	26729	4	30269	1
22123	3	24469	5	26821	5	30341	4
22133	1	24473	1	26849	1	30389	1
22189	5	24509	1	26927	4	30431	3
22273	5	24527	3	26947	3	30449	1
22343	3	24623	3	26993	1	30467	3
22349	1,4	24631	3	27077	4	30539	4
22409	1	24659	4	27143	3	30677	4
22433	1	24671	4	27197	4	30689	1
22447	3	24691	3	27281	1	30773	1
22469	1	24749	1	27527	4	30911	3
22481	1	24971	3	27581	1	30971	4
22541	1	25073	1	27691	3	31063	3
22787	4	25147	3	27773	1	31181	4
22811	4	25229	1	27809	1	31223	3
22853	1	25247	3	27851	3	31253	1
22861	5	25367	3	27893	1	31327	3
23081	4	25457	4	27947	4	31469	1
23321	1,4	25537	5	27983	3	31649	1
23417	4	25583	3	28001	1	31721	1
23531	4	25601	1	28087	3	31723	3
23561	1	25673	1	28793	1	31793	1
23567	3	25763	3	28901	1	31883	3
23603	3	25841	1	28949	1	32009	1
23669	1	25867	3	28961	1	32141	1
23677	5	25913	1	29021	1	32323	3
23741	4	25951	3	29033	1	32363	3

p	k	p	k	p	k	p	k
32381	1	35081	1	38371	3	42089	1
32443	3	35201	4	38453	1	42221	1
32561	1,4	35327	4	38501	1	42331	3
32573	1	35573	1	38669	1	42473	1
32633	1	35591	4	38783	3	42643	3
32789	1,4	35759	4	38861	1	42703	3
32933	1	35831	3	38873	1	42727	3
32939	4	35863	3	38933	1	42821	1
32957	4	35933	1	39089	1	43013	1
33053	1	35993	1	39163	3	43313	1
33247	3	36263	3	39233	1	43403	3
33329	4	36353	1	39443	3	43411	3
33461	1	36629	1	39511	3	43541	1
33521	1	36691	3	39521	1	43649	1
33569	1	36761	1	39563	3	43661	1
33617	4	36791	3	39569	1	43721	1
33713	1	36821	1	39791	3	43793	1
33749	1	36929	1	39953	1	44129	1
33773	1	36931	3	39989	1	44189	1
33791	3	36943	3	40123	3	44249	1
33809	1	37013	1	40127	3	44263	3
33941	1	37049	1	40193	1	44273	1
34211	3	37139	4	40343	3	44483	3
34253	1	37181	1	40853	1	44501	1
34267	3	37253	1	40949	1	44623	3
34327	3	37307	3	41081	1	44729	1
34367	3	37447	3	41381	1	44909	1
34487	3	37643	3	41609	1	44987	3
34603	3	37747	3	41621	1	45053	1
34871	3	37853	1	41669	1	45329	1
34913	1	38189	1	41729	1	45569	1
34949	1	38201	1	41887	3	45641	1
35023	3	38327	3	41911	3	45887	3
35051	4	38333	1	41969	1	45971	3
35069	1	38351	3	42023	3	46181	1

p	k	p	k	p	k	p	k
46229	1	52121	1	57773	1	64901	1
46349	1	52289	1	57881	1	65129	1
46589	1	52361	1	58013	1	65309	1
46703	3	52553	1	58049	1	65393	1
46723	3	52733	1	58193	1	65633	1
46751	3	53093	1	58601	1	66029	1
47051	3	53309	1	58889	1	66173	1
47189	1	53453	1	59021	1	66593	1
47501	1	53549	1	59369	1	66701	1
47513	1	53849	1	59393	1	66749	1
47609	1	54101	1	59453	1	67121	1
47741	1	54293	1	59513	1	67169	1
47743	3	54401	1	59621	1	67181	1
48029	1	54413	1	59981	1	67349	1
48221	1	54773	1	60149	1	67433	1
48413	1	54941	1	60293	1	67733	1
48593	1	55229	1	60449	1	68261	1
48761	1	55469	1	60509	1	68489	1
49193	1	55661	1	60689	1	68669	1
49253	1	55673	1	60761	1	69029	1
49391	3	55721	1	60773	1	69341	1
49433	1	55733	1	61409	1	69593	1
49481	1	55829	1	61469	1	69809	1
49747	3	55889	1	61961	1	69941	1
49853	1	56009	1	62213	1	70061	1
50021	1	56081	1	62501	1	70181	1
50261	1	56393	1	62753	1	70313	1
50273	1	56489	1	62981	1	70589	1
50513	1	56681	1	63113	1	70769	1
50741	1	56909	1	63929	1	70793	1
50873	1	56921	1	64301	1	70853	1
50969	1	57041	1	64373	1	70901	1
50993	1	57149	1	64709	1	71453	1
51521	1	57329	1	64793	1	71693	1
51893	1	57413	1	64853	1	71741	1

p	k	p	k	p	k	p	k
71849	1	78653	1	84713	1	93113	1
72101	1	78713	1	84761	1	93581	1
72161	1	79181	1	85049	1	93893	1
72269	1	79349	1	85061	1	93941	1
73421	1	79433	1	85121	1	94229	1
73553	1	79589	1	85133	1	94421	1
73589	1	79613	1	85313	1	95261	1
73613	1	79769	1	85601	1	95393	1
73673	1	79841	1	85733	1	95549	1
73709	1	79889	1	85829	1	95561	1
74201	1	80309	1	85853	1	95789	1
74381	1	80369	1	86441	1	95813	1
74729	1	80669	1	87149	1	95873	1
74933	1	80681	1	87221	1	96269	1
75041	1	81281	1	87701	1	96293	1
75149	1	81509	1	88661	1	96461	1
75161	1	81629	1	89153	1	96581	1
75329	1	81701	1	89909	1	96989	1
75353	1	81929	1	90089	1	97001	1
75389	1	82073	1	90173	1	97241	1
75689	1	82193	1	90281	1	97829	1
75821	1	82493	1	90641	1	98321	1
75833	1	82529	1	90749	1	98369	1
75941	1	82601	1	90833	1	98453	1
76001	1	82721	1	91121	1	98561	1
76421	1	82793	1	91193	1	98573	1
76781	1	82889	1	91373	1	98621	1
77261	1	83813	1	91433	1	98669	1
77513	1	83873	1	91529	1	98849	1
77813	1	84401	1	91841	1	98981	1
77847	1	84449	1	92681	1	99041	1
78173	1	84509	1	92849	1	99089	1
78233	1	84533	1	92861	1	99173	1
78341	1	84629	1	92993	1	99689	1
78509	1	84653	1	93053	1	99761	1

p	k	p	k	p	k	p	k
100361	1	108401	1	115781	1	125201	1
100493	1	108821	1	116969	1	125693	1
100913	1	108869	1	117041	1	125921	1
101333	1	108929	1	117101	1	126653	1
101429	1	109001	1	117269	1	126713	1
101681	1	109229	1	117329	1	127373	1
101693	1	109313	1	117989	1	127481	1
101789	1	109481	1	118169	1	127493	1
101921	1	109541	1	118361	1	127541	1
102149	1	109793	1	118589	1	127709	1
102293	1	109841	1	119429	1	127733	1
102461	1	110609	1	119513	1	127973	1
102593	1	111029	1	119849	1	128153	1
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103349	1	111641	1	120293	1	128669	1
103409	1	111773	1	120833	1	128813	1
103613	1	111833	1	120941	1	128993	1
104033	1	112181	1	121853	1	129221	1
104369	1	112289	1	122021	1	129281	1
104393	1	112349	1	122201	1	129401	1
104561	1	113153	1	122273	1	129509	1
104729	1	113189	1	122393	1	129581	1
104789	1	113213	1	122861	1	129749	1
105173	1	113453	1	123269	1	129953	1
105401	1	113513	1	123341	1	130241	1
105533	1	114221	1	123401	1	131321	1
105701	1	114269	1	123449	1	131441	1
105929	1	114641	1	124121	1	131861	1
106121	1	114749	1	124133	1	131909	1
106433	1	114773	1	124433	1	131933	1
107021	1	115001	1	124493	1	132329	1
107441	1	115061	1	124529	1	132701	1
107741	1	115469	1	124769	1	132893	1
108089	1	115553	1	124781	1	133013	1

p	k	p	k
133649	1	140069	1
133709	1	140249	1
133949	1	140681	1
134489	1	140813	1
134609	1	141353	1
134789	1	141413	1
135029	1	142193	1
135221	1	142589	1
135281	1	143249	1
135329	1	143501	1
135449	1	143609	1
135461	1	143873	1
135533	1	144341	1
135581	1	144569	1
135893	1	145109	1
136133	1	145121	1
136541	1	145709	1
136949	1	145721	1
137201	1	145949	1
137369	1	146141	1
137393	1	146213	1
137573	1	146669	1
137849	1	146801	1
137993	1	147029	1
138041	1	147089	1
138389	1	147401	1
138581	1	147629	1
138629	1	148013	1
138821	1	148829	1
138893	1	148853	1
139109	1	149021	1
139313	1	149153	1
139409	1	149213	1
139589	1	149333	1
139721	1	149843	1

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This report is concerned with determining the primeness of the members of a class of numbers of the form, $B_p = \frac{2^p + 1}{3}$, where p is an odd prime. This class is similar to the Mersenne and Fermat numbers. A theorem is proven which characterizes the factors of B_p. This study was conducted using BRLESC, the high-speed digital computer at BRL and a description is given of the program used. Finally, the B_p's that were found to be prime as well as the B_p's that were found to be composite are tabulated.

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